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# FLAT CONDUCTOR TECHNOLOGY EXEMPLIFIED

Astrionics Laboratory



*George C. Marshall*
*Space Flight Center,*
*Huntsville, Alabama*

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## ABSTRACT

Combining printed circuit and flat conductor cable technology led to the development of a unique multilayer printed circuit board* which is ideal for reducing weight, saving space, and eliminating other problems that are characteristic of conventional round-wire harnesses.

This report portrays the changes made to a typical signal conditioning rack as an example of the evolutionary phases that took place during development of the new board. The results obtained with the new technique show that the method is electrically, mechanically, and economically more practical than that used in preparing conventional round-wire harnesses.

* The multilayer printed circuit board was developed through the coordinated efforts of Prototype Development Branch (R-ASTR-P); Instrumentation and Communication Division (R-ASTR-I); and Electro-Mechanisms Incorporated, a subsidiary of Brown Engineering Company.

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## SUMMARY

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This report portrays the changes made to a typical signal conditioning rack as an example of the evolutionary phases that took place during development of the new board. The results obtained with the new technique show that the method is electrically, mechanically, and economically more practical than that used in preparing conventional round-wire harnesses.

## INTRODUCTION

The first phase of development began primarily with an attempt to reduce the weight of vehicle flight equipment. The lightness of flexible printed circuits was recognized as a possible answer, so the first approach was to replace only the round wire with flat conductors. Design and production of the flat conductors were conveniently accomplished through flexible printed circuit technology, and the strips of printed conductors were installed in a stacked arrangement similar to a typical flat conductor cable installation. This arrangement alleviated the problems of weight, space, and electromagnetic interferences; but the feasibility of soldering flat conductors to conventional receptacles did not prove entirely satisfactory.

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The next phase of improvement retained the flexible circuit technology; but rather than simply stacking, the circuit layers were redesigned and bonded together to form a multilayer printed circuit board. The use of a new type of signal conditioning pack receptacle that could be mounted upon and supported by the board was also incorporated. Even this phase did not eliminate the round-wire cable receptacles. The unbonded sheets of conductors were designed to protrude as free, flexible groups that were necessarily terminated in conventional, chassis-supported receptacles. This technique finally gave way to a third phase of development and a new technology, whereby the groups of flexible conductors were terminated with plug assemblies that are ordinarily used to terminate flat conductor cables.

# DESCRIPTION

## Round-Wire Harness

Figure 1 shows the original round-wire harness and illustrates that a large amount of shielded wire was used to prevent interference. Wiring support rods were also necessary to assure reliable operation throughout extreme conditions of vibration. These characteristics, along with the more solid chassis that is required for mounting conventional receptacles, are big factors in the problems of weight.

## Flat Conductor Harness

The flat conductor harness (Fig. 2) eliminated the heavy wire and wire routing supports, but required a somewhat precise and systematic method of installation. Small pins were soldered into the solder cups of each signal conditioning pack receptacle (Fig. 1). The insulation of each strip of conductors was perforated so that the solder pins could extend through to the appropriate solder pad for soldering. The first strip of conductors (bottom layer) was positioned, and the pins were soldered to the solder pads of that strip. Each successive layer was installed in like manner. (Note the offsets in conductor routing to accommodate solder pad positions.)

## Multilayer Printed Circuit Board with Flat Cable Terminations

The first printed circuit board (Fig. 3) was designed to accommodate a new type of signal conditioning pack receptacle (Fig. 4), which could be supported by the "mother board" rather than being attached directly to the chassis. All other conventional receptacles were retained, however, and the various groups of flexible leads were terminated with correspondingly arranged solder pads. Another approach was to arrange the solder pads to accommodate the use of rectangular-shell receptacles (Fig. 4). This technique afforded definite advantages but was not completely satisfactory because of the skill and time required to make solder connections. The final printed circuit board (Fig. 5) contains flexible leads that are terminated with the plug assemblies ordinarily used to terminate flat conductor cables. These plugs are inserted into standard wall-mounted feed-through flat cable receptacles for systems interconnection.

# ANALYSIS

The projection of continuous flexible leads from the layers of a rigid multilayer printed circuit board is perhaps the most significant aspect of the techniques used in this example. This allows the combining of printed circuit and flat cable technology into an item that is superior to a round-wire harness in every respect. Electrically, it is more reliable under adverse conditions of interference and vibration. Exact repetition of electrical properties is more consistent in identical harnesses produced through flat conductor technology than in those produced by hand from round wire. Mechanically, it approaches the simplicity of a plug-in unit or module that can be installed or removed quickly. Economically, it affords the possibility of mass production where many items of a kind are required and, in any event, eliminates much of the time and dexterity that is required for the assembly of round wire.

The advantages gained through the application of flat conductor technology are many fold and far reaching. The new design reduces weight and space, produces more efficient circuitry, and reduces cost of production.

# CONCLUSION

In view of the results obtained in this case, it is logical to conclude that electronic equipment of this and related types can be greatly improved through the extended use of etched circuitry and junction-free flat conductor cable termination technology.

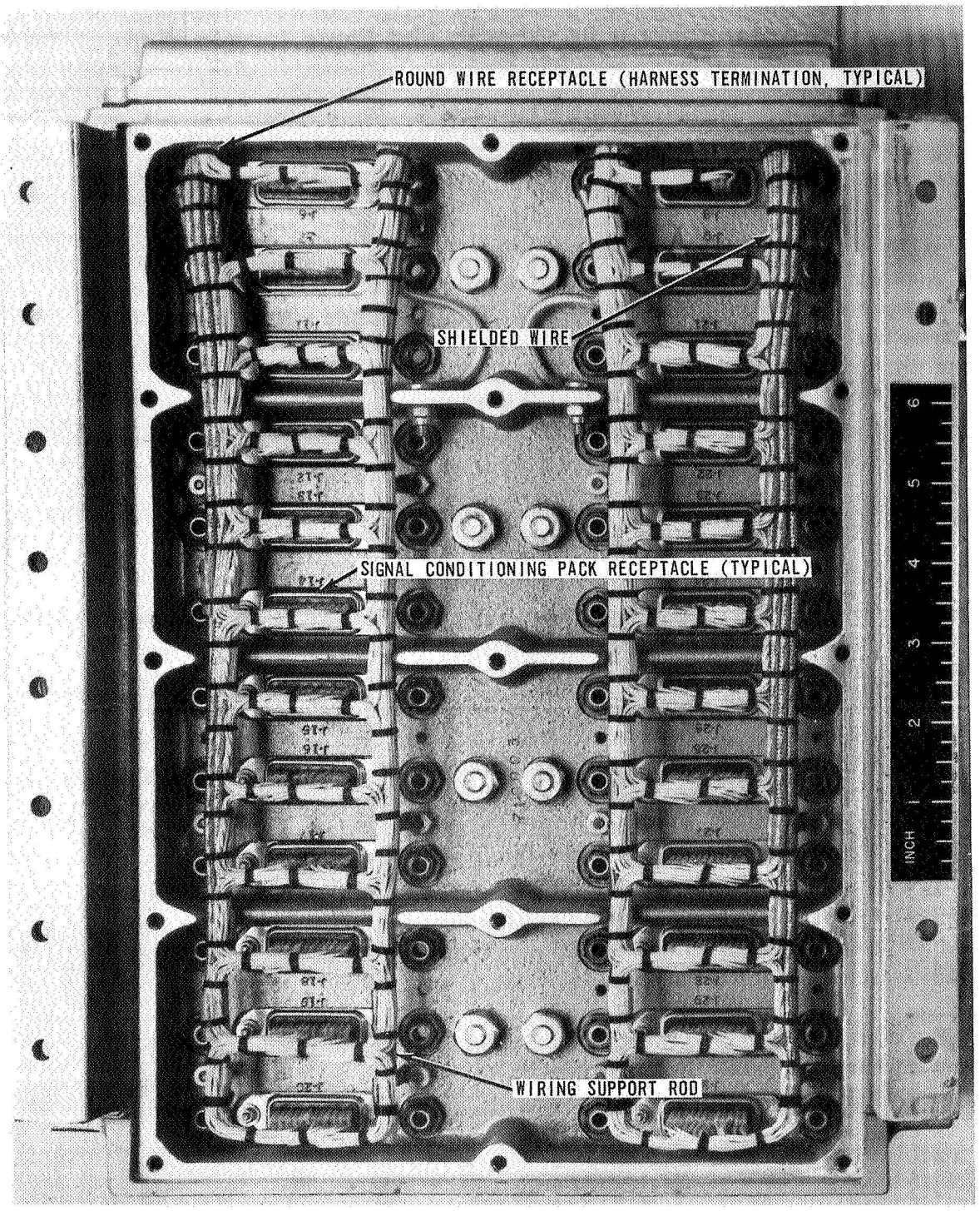


FIGURE 1. ROUND-WIRE HARNESS

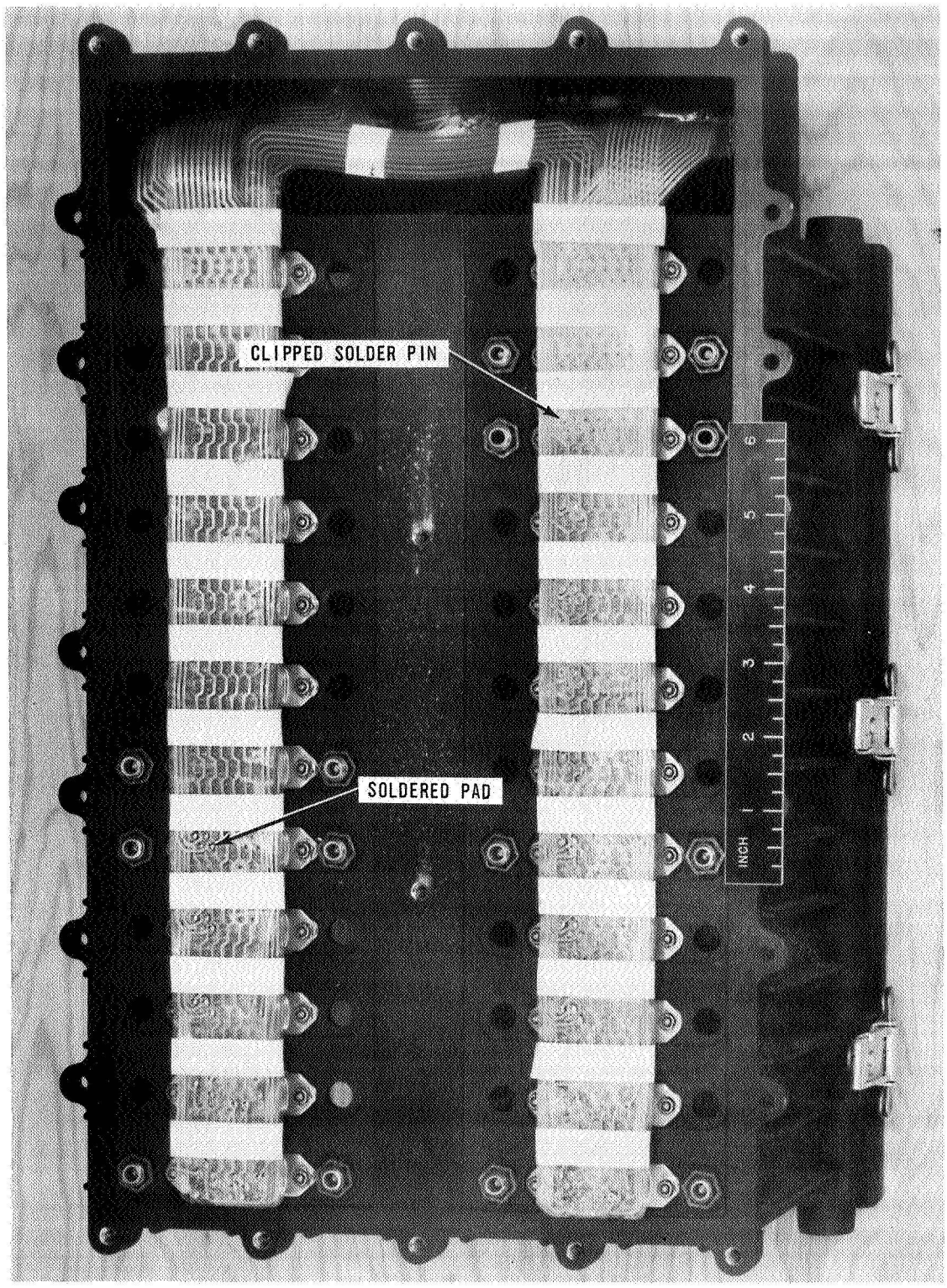


FIGURE 2. FLAT CONDUCTOR HARNESS

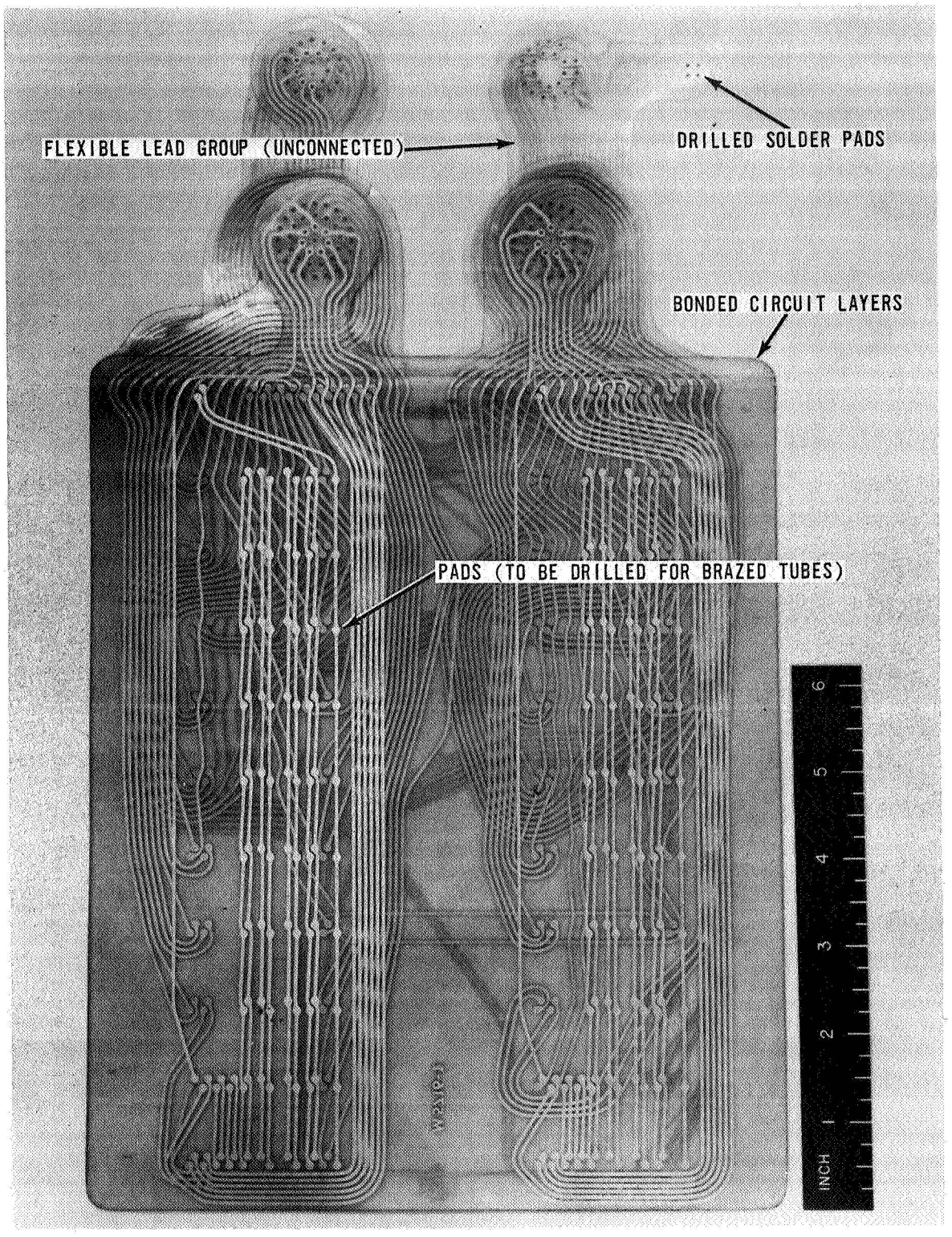


FIGURE 3. FIRST PHASE OF PRINTED CIRCUIT BOARD DEVELOPMENT

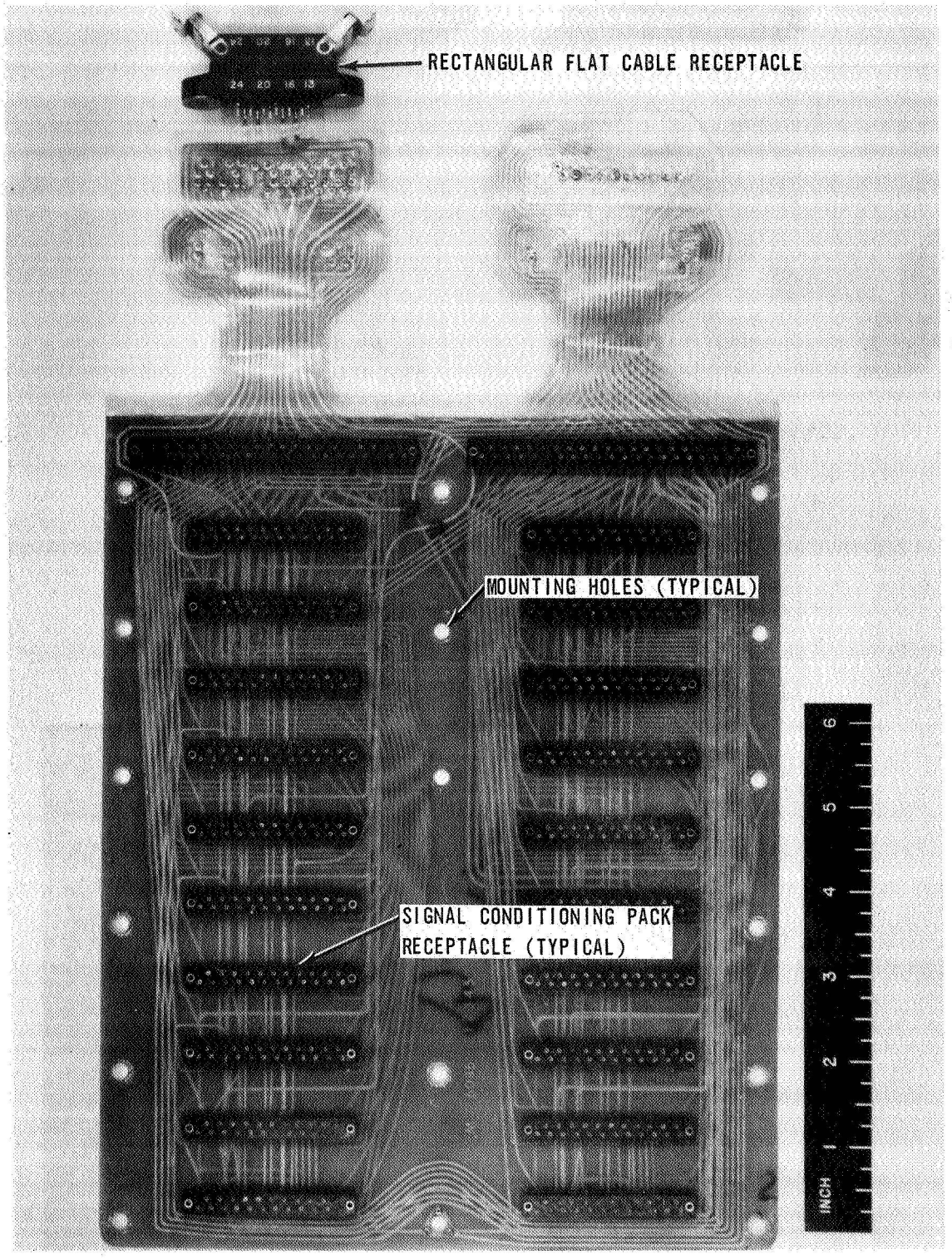


FIGURE 4. SECOND PHASE OF PRINTED CIRCUIT BOARD DEVELOPMENT

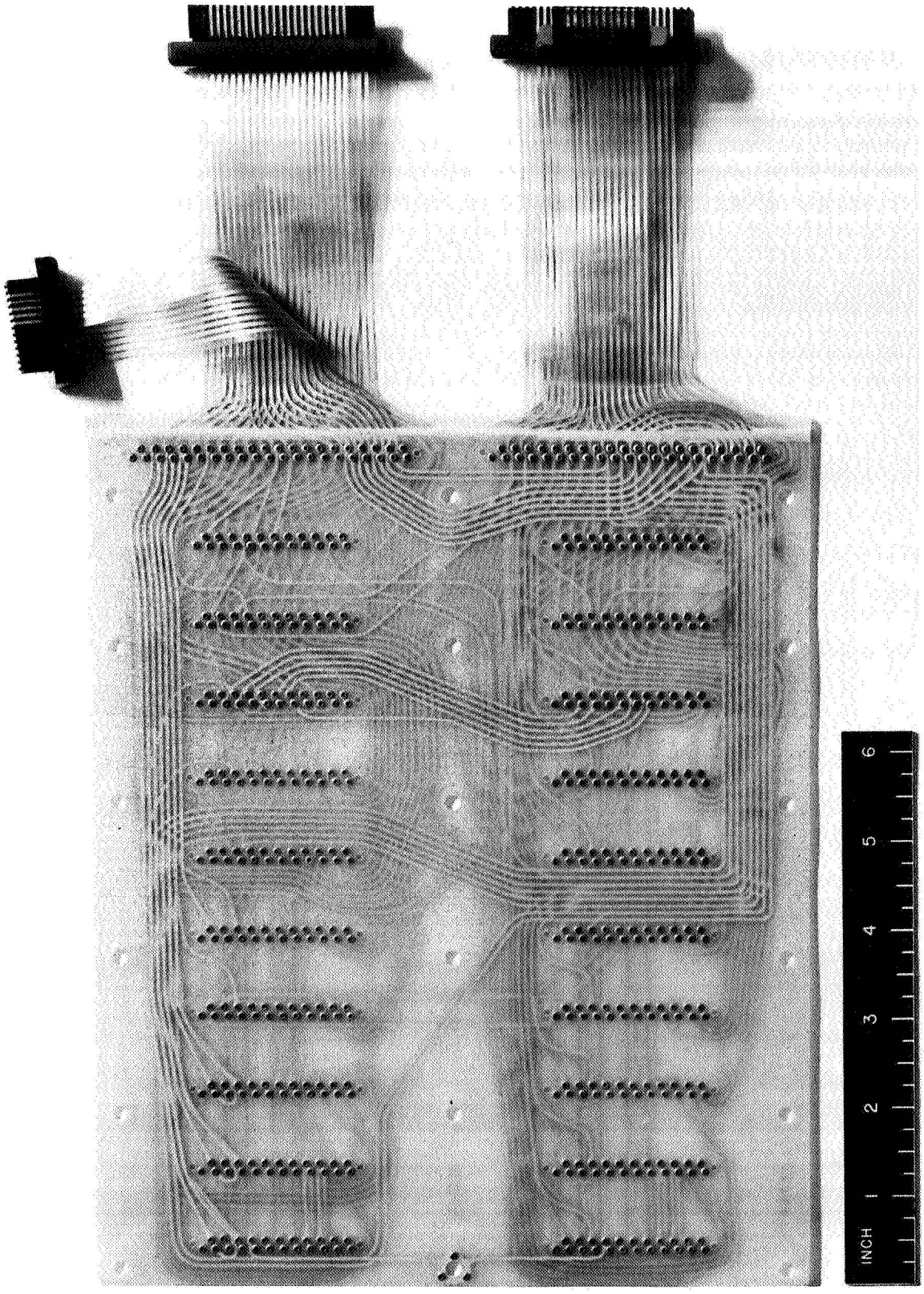


FIGURE 5. FINAL FORM OF PRINTED CIRCUIT BOARD WITH FLAT CABLE TERMINATIONS

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The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

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